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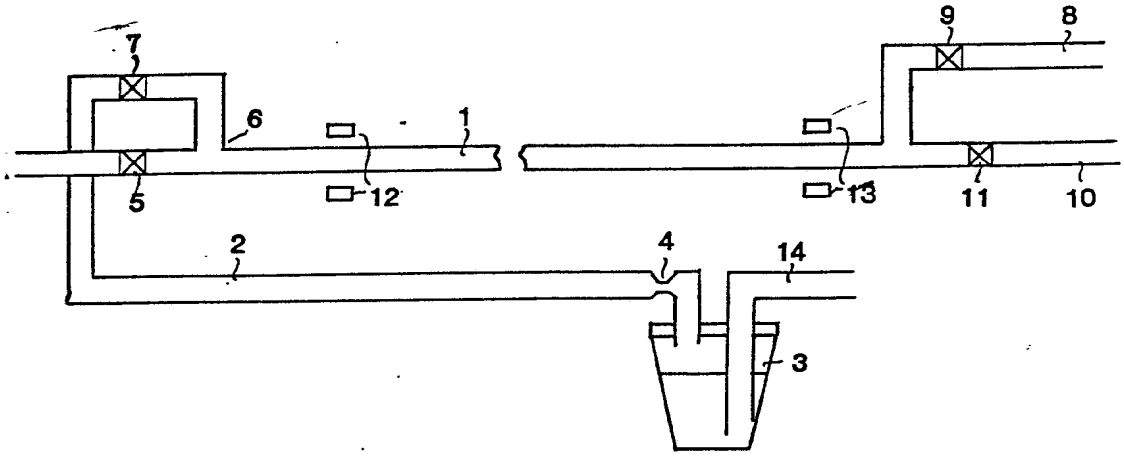
(54) Title: TRANSMISSION OF SMALL VOLUMES OF LIQUID SAMPLES



(57) Abstract

Method and device for the transmission of small blood samples from a sampling site to a place for a treatment of said blood sample, whereby a blood sample is separated off in a transporting tube (1) and by means of a transporting gas, which is placed under pressure (pressure or vacuo) is transported from a sampling site to said place for treatment thereof.

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TRANSMISSION OF SMALL VOLUMES OF LIQUID SAMPLES

DESCRIPTION

Technical field

The present invention relates to a method and a device for transmitting small volumes of blood samples from a sampling site to a place for analysis thereof, without substantially changing the sample with regard to volume and physical form.

The object of the present invention is to obtain a possibility of transferring a small blood sample being in the form of a liquid from a sampling site to a place where it will be analysed such as to a continously or semicontinously working analyzing instrument. Particularly, it is related to the transfer of a blood sample from a patient to a blood analyzing instrument, as a blood gas analyzing instrument used in intensive care and during surgical incisions.

Background of the invention.

In surgical and intensive care there is a need for a frequent control of the blood status of a patient, and thereby the condition of the patient, by analyzing its blood. However, there is simultaneously no possibility of placing a blood analyzing instrument immediately next to a patient due to the bulky volume of the analyzing instrument, as one constantly must have a possibility to come close to the patient for surgical and other care.

During operation and intensive care it is most often necessary to check the patient's blood gases, i.e., pO_2, pCO_2, and pH in order to control the patient's ventilation.

Insufficient ventilation, which threats main vital functions is compensated for by assisted or wholly replaced artificial ventilation, manually, or mechanically.

In order to set, i.e. to dose, the ventilation certain nomogrammes calculated on the basis of such parameters as body length, body weight, and body surface area are used. The arbitrary dose of the ventilation volume which is hereby achieved is checked daily with one or more

daily using one or more blood gas analyses. In certain cases which are hard to control and very often in children, there is a demand for closer analyses to be made. In investigations made it has been noted that changes in position (Trendelenburg), pressure against thorax, and pressure of wound clamps against the diaphragma during anesthesia, each alone or taken together, can disturb the ventilation considerably so that it may become insufficient.

It should have been an ideal situation if one could be able to control the ventilation by a continous or at least high frequent blood gas analysis to thereby secure normal oxygenation and carbon dioxide elimination.

With regard to the dosage of oxygen during ventilation controlled by a respirator it can be of value, during certain conditions, as at chronical lung diseases, when the patient accomodates to a low oxygen pressure and a high carbon dioxide pressure, to carefully follow the blood gas values. Hereby the development may lead to the situation that the analysis values can control the dosage of oxygen by the respirator so that a desired oxygen pressure can be maintained. That is to say that tha biological data that are at hand can control the treatment electronically.

In experiments made one has tried to let a very slow flow of blood (100µl/min) pass from a patient to a blood gas analyzing instrument being placed placed 2 metres away from the patient. This has however, created great problems in that tha blood has a great tendency to coagulate, which leads to clogging of the fine lumens that are used in the catheters in question. Further, the low flow rate leads to an unnecessary delay in analyzis answers, and, finally, the method gives very instable values, which can not be used for controlling the ventilation course, due to the fact that the analyzing electrodes are in constant contact with blood.

One has also tried to place the electrodes in a satellite

of the analyzing instrument close to the patient, which method, however, is very inpractical as the electrodes have to be heated by means of a water bath, which in turn leads to too a large volume of the satellite. Further, an electrical reconnection to the instrument itself must take place, which in turn leads to unstabile values depending on an amplifying enlargement. Further, too a large parcel of electrodes is obtained as heating shall be carried through. The parcel will thereby be 20x20x15 cm.

As evident from above there is a need for obtaining a possibility to transfer blood samples relatively long distances from a sampling site to an analyzing instrument.

Description of the present invention.

It has now surprisingly been shown possible to meet this need by means of the present invention, which is characterized in that a blood sample is separated off in a transport tube, and by means of a transporting medium, which does not affect the blood sample, and which is placed under pressure, and is transported from a sampling site to a place for analysis of the sample.

Further features and characteristics of the invention are evident from the accompanying claims.

The invention will be described more in detail below with reference to the attached drawing, wherein

Fig.1 shows a schematic view of a device according to the invention;

Fig.2 shows a schematic view of another device according to the invention; and

Fig.3 shows schematically a number of submoments in the transmission of a sample in accordance with the invention.

As evident from what has been said above the invention relates prima facie to the transmission of a blood sample from a sampling site to a place for treatment of the sample, such as

an analyzing instrument. Thus the analyzing instrument does not form a part of the invention but the invention as the method and device for carrying out the method is intended to be connected to any analyzing instrument present on the market, such as blood gas analyzing instruments, as the analyzing instruments of the mark International Laboratories types IL 413 and IL 613.

In Figs. 1 and 2 1 denotes a transmission tube such as a catheter having a lumen of down to one or some millimetres. A tube 2 is connected to the transmission tube 1, which tube 2 is connected to a transporting medium in the form of a gas. The tube 2 is connected to a gas container 3. Further an adjustable flow resistance device 4 is arranged in the tube 2, which device 4 in Fig.1 is placed after the container 3, and in Fig.2 is placed in front of the container 3. The tube 1 is in its one end, which is intended to be connected to a sampling site, such as a patient's arm via a cannula (not shown) provided with a valve 5. The tube 2, which is connected to the transmission tube 1 close to said end by means of a T-connector 6, is also provided with a valve 7, which cooperates with the valve 5 from a security and functional point of view. The transmission tube 1 is in its end turning away from the patient's arm provided with a connector 8 provided with a valve 9, and an analyzing instrument connector 10 provided with a valve 11. The analyzing instrument to which the tube 1 is connected is not shown. The connector 8 is connected to a suction source providing a vacuo of 0.05-0.3 kp/cm^2. In the analyzing instrument there is a further suction source which makes a part of the instrument and is intended to suck a sample into the analyzing instrument regardless of how it is otherwise used. Along the transmission tube 1 there are two signal stations 12, and 13, of which one, 12, is situated on a small distance from the sampling end, and the other, 13, is situated on a small distance from the analyzing instrument end, prior to the connector 8. The signal stations 12 and 13 can either consist of a light source/photocell or of electrical conductivity meters.

The tube 2 is, as stated above, connected to a gas container 3 which in the embodiment herein described, in its turn, via a tube 14 is connected to a gas source (not shown). When gas is used as a transporting medium and a blood gas analysis shall be carried out the gas has such a composition that a transmitted blood sample is not affected. Such a composition can be 12% O_2, 5% CO_2, and 83% N_2, which corresponds to pO_2=85.56 mm Hg, and pCO_2=35.65 mm Hg. The gas can further be moistened in the container 3 by being bubbled through an aqueous medium. If a blood sample should be transmitted and analyzed, then the gas is siutably moistened with a solution of heparine, whereby the container 3 the contains heparine, which is an anticoagulantia.

In the embodiment of Fig.2 there is a shunt 15 placed in connection to the signal station 13 and connected on the sampling side of said station 13. The shunt 15 is provided with a valve 16. In the embodiment of Fig.2 the flow resistance 4 is further made as a throttle and is placed on the gas source side of the container 3.

The function of the device will now be described more in detail with reference to the sampling of a blood sample from a patient to a blood gas analyzing instrument. It is hereby referred to Fig.3 which shows different submoments in the transport of a blood sample. The device is, on the one hand connected to a patient via a cannula, to the left in the figure, and on the other hand to a blood gas analyzing instrument, to the right in the figure. In starting position heparine moistened transporting gas of the composition given above is sucked through the tube 1 from the tube 2 and out through the connector 8 with a vacuo of 0.3 kp per cm^2. Hereby the valves 7,and 9 are both open, and the valves 5, and 11 are both closed. The cannula which has been entered into an artery leads blood up to the valve 5 with the blood pressure of 100 to 200 mm Hg. In the next moment(2) the analyzing instrument calls for a sample. Hereby the valve 5 opens and the valve 7 is simultaneously closed, whereby

blood is pressed and sucked into the tube 1. When the blood comes up to the signal station 12, this gives a signal indicateing that thereby a certain tube length of blood has arrived into the tube 1, whereby the valve 5 closes and the valve 7 opens. In this way a certain amount or volume of blood, 100 to 250 µl in this case, has been separated off, and as the valve 7 has been opened, transporting gas will, depending on the pressure present (vacuo), transport the blood column towards the signal station 13 with a speed of 3 to 8 m per min., normally 4 mper min.. When the blood sample reaches the signal station 13, this notifies this fact, whereby the valve 9 of the connector 8 closes, whereby the sample stops. The analyzing instrument is, for example, in this case not ready to accept a new sample depending on the fact that it is occupied with cleansing after a previous sample. When the analyzing instrument is ready, this is informed, and the valve 11 opens and the suction source of the analyzing instrument takes over the transport of the sample into the analyzing instrument. In the case the embodiment of Fig.2 is used, the valve 16 is simultaneously opened as well, whereby a greater pressure is applied onto the rear side of the blood sample, and this is thereby more easily transported into the analyzing instrument.

The different submoments are shown in Fig.3, subfigures 1 to 6, whereby further in subfigures 7,8, and 9, a diversion tube has been inserted on the tube 10, which diversion tube is provided with a valve. The tube denotes a waste tube for analyzed samples, whereby, as evident from the position of the valve it is known when an analyzed sample is washed out.

The flow resistance in the qube 2 should be quite dominant to the system in order to give a stable transport of a sample. The flow resistance $\underline{R}$ of the tube 2 shall, compared with the flow resistance $\underline{r}$ of the cannula, thus be $\underline{r} << \underline{R}$.

At blood gas analyses two samples per minute can be analyzed theoretically. The practical frequency is, however, somewhat lower depending on the subsequent cleansing of the electrodes and cmptying of the instrument.

CLAIMS.

1. A method for the transmission of a blood sample having a small volume from a sampling site to a place for a treatment of the sample, characterized in that a blood sample is separated off into a transport tube (1), and by means of a transporting gas, which does not affect the blood sample, and which is placed under pressure, and is transported from a sampling site to a place for analysis of the sample.

2. A method according to claim 1, wherein the transporting gas is transported by means of vacuo through the transport tube (1).

3. A method according to claim 1, wherein a sample is introduced into the transport tube (1) by means of a vacuo, and is separated off by said transport gas by introducing this into the transport tube (1) when a predetermined amount of blood has been introduced into said tube (1).

4. A method according to claim 1, wherein the transport gas is introduced into the transport tube (1) in connection to and in the vicinity of the site, where the sample leaves the transport tube (1).

5. A method according to claim 1, wherein the transporting gas is moistened, preferably including heparine.

6. A method according to claim 1, wherein the transporting gas comprises oxygen and carbon dioxide in amounts corresponding to a pO_2 of about 85.56 mm Hg, and a pCO_2 of about 35.65 mm Hg.

7. A device for transmitting a blood sample having a small volume over a relatively long distance from a sampling site to a place for a treatment of the sample, characterized in that it comprises a transport tube (1) intende to be connected in its one end to a sampling site and in its other end to an analyzing instrument; a tube for a transporting gas

arranged to the transporting tube (1) in the vicinity of the sampling site and being connected to a pressure source; at least one signal station (12) for the detection of a sample, which signal station (12) is arranged in the vicinity of said connection of the transporting gas tube (2) to said transport tube (1) for the measurement of a sample; and valves (5,7) for closing and opening of said two tubes (1,2) for the control of a transport of a sample; and whereby the tube (2) for transporting gas is provided with a flow resistance (4).

8. A device according to claim 7, wherein the tube (2) for transporting gas is also connected to the transporting tube (1) in the vicinity of the place for the treatment of the sample.

9. A device according to claim 7, wherein the transporting tube (1) is provided with a further signal station (13) for the detection of the presence of a blood sample for the further control of the final transport of the sample to the place for treatment thereof.

10. A device according to claim 7, wherein the tube (2) for the transporting gas is provided with means for moistening said gas.

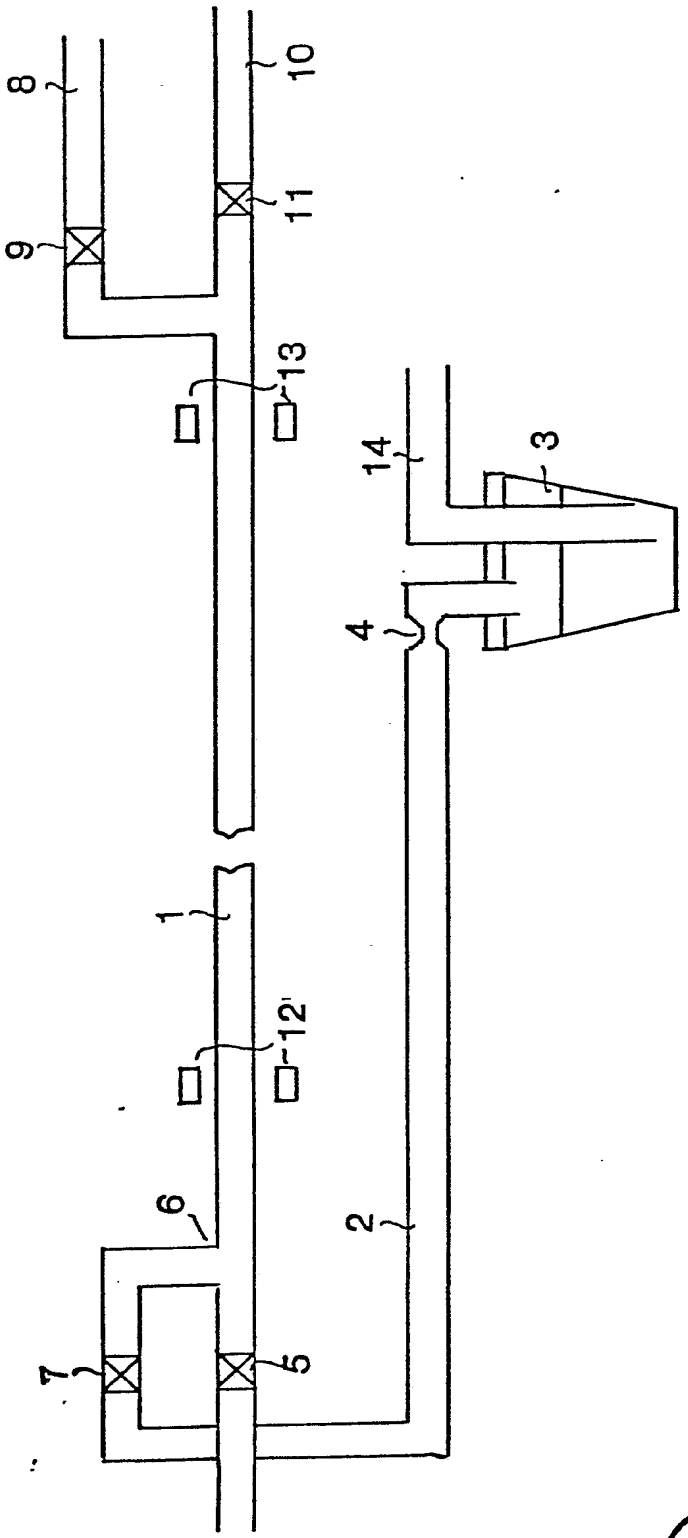

FIG 1

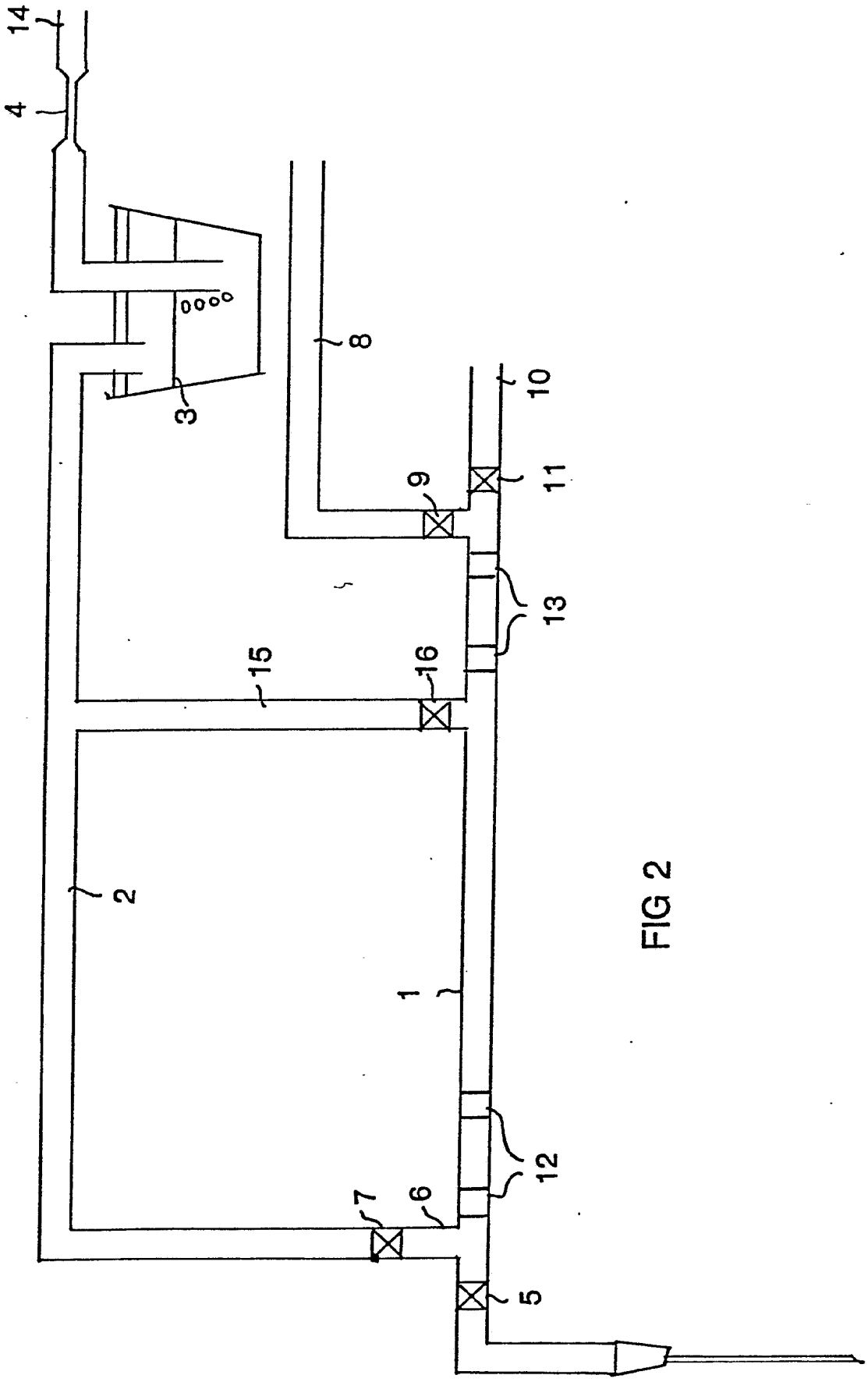

FIG 2

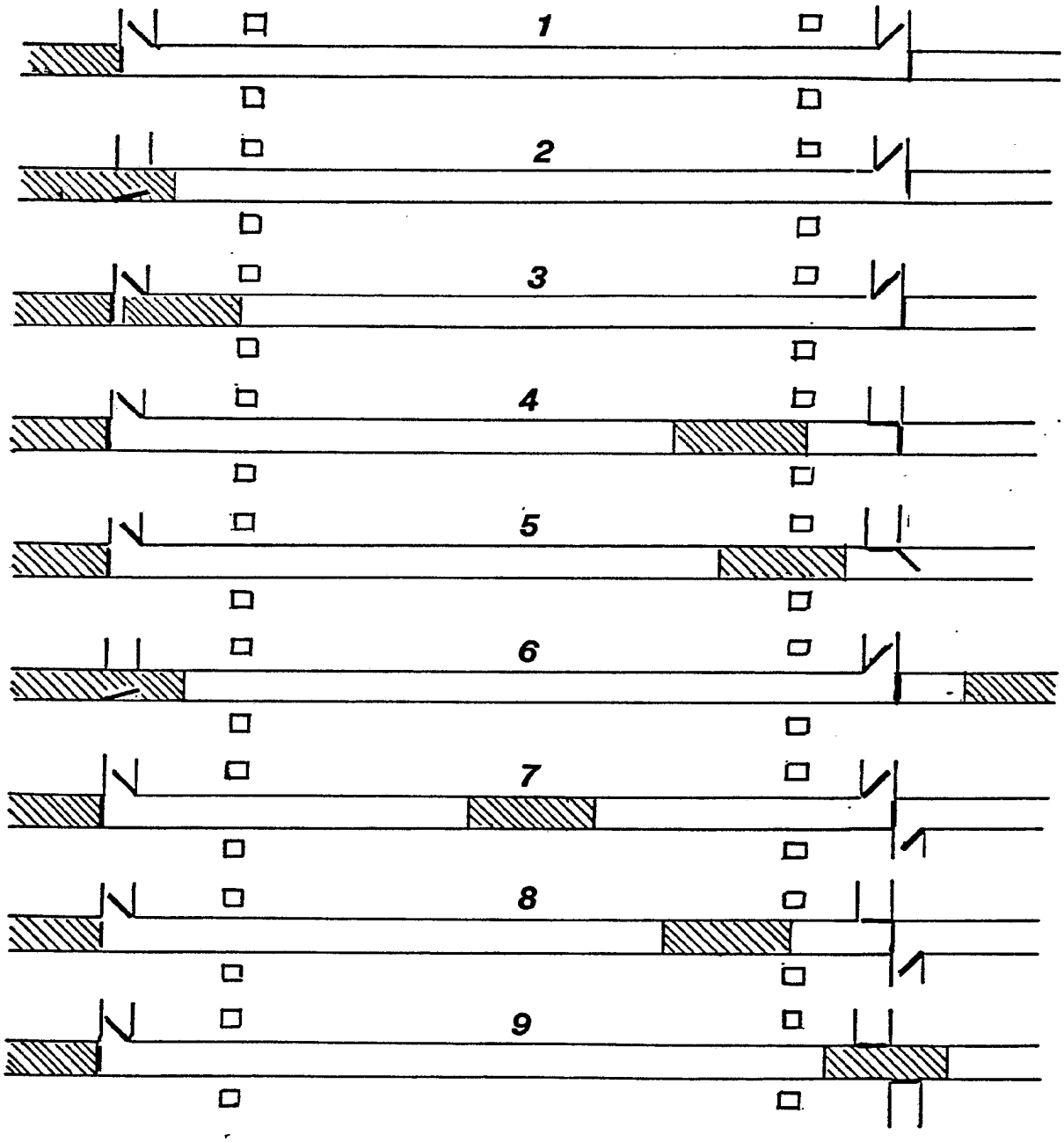

FIG 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE83/00082

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC 3

A 61 M 1/00; G 01 N 35/08

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC 3	A 61 B 5/14; A 61 M 1/00,03,G 01 N 35/00,08, 37/00
US Cl	23:259, 230; 128:635; 422:81, 82, 100

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A X	US, A, 4 263 922 (AMERICAN HOSPITAL SUPPLY CORPORATION) 28 April 1981	1-10 5
X	DE, B2, 1 598 260 (CESKOSLOVENSKA AKADEMIE VED) 17 December 1970 & SE, B, 336 476	1-10
X	SE, B, 357 443 (TECHNICON CORPORATION) 25 June 1973	1-10
X	US, A, 3 876 374 (TECHNICON INSTRUMENTS CORPORATION) 8 april 1975 see claims 8-10 and 21-23 & SE, B, 419 267	1-10

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IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
1983-06-09	1983 -06- 16
International Searching Authority [1]	**Signature of Authorized Officer** [20]
Swedish Patent Office	Solveig Arvidsson Solveig Arvidsson

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